IN-46
322936

Progress Report for Grant NAG 5-2963

Solar cycle dynamics of solar, magnetospheric, and heliospheric particles, and long-term atmospheric coupling: SAMPEX

Period: July 1, 1997 - July 1, 1998

University of Maryland
Aerospace Corporation
California Institute of Technology
University of Colorado
Goddard Space Flight Center
Langley Research Center
Max-Planck-Institut für extraterrestrische Physik

July 1998

Progress Report: Solar cycle dynamics of solar, magnetospheric, and heliospheric particles, and long-term atmospheric coupling: SAMPEX

Principal Investigator:

G. M. Mason
Department of Physics
University of Maryland
College Park, MD 20742
(301) 405-6203

Co-Investigators:

J. B. Blake
Aerospace Corporation M2/259
P.O. Box 92957
Los Angeles, CA 90009
(310) 336-7078

R. A. Mewaldt
E. C. Stone
220-47 Downs Laboratory
California Institute of Technology
Pasadena, CA 91125
(626) 395-6612

D. N. Baker
Laboratory for Atmospheric and Space Physics
University of Colorado
Boulder, CO 80302
(303) 492-0591

T. T. von Rosenvinge
Project Scientist
NASA Goddard Space Flight Center
Greenbelt, MD 20771
(301) 286-6721

L. B. Callis
NASA Langley Research Center
MS 401B
Hampton, VA 23665-5225
(757) 864-5843

D. C. Hamilton
Department of Physics
University of Maryland
College Park, MD 20742
(301) 405-6207

B. Klecker
D. Hovestadt
M. Scholer
Max-Planck-Institut für extraterrestrische Physik
D-85740 Garching
Germany
49-89-3299-3872

Table of Contents

Progress Report for Grant NAG 5-2963

Solar cycle dynamics of solar, magnetospheric, and heliospheric particles, and long-term atmospheric coupling: SAMPEX

Period: July 1, 1997 - July 1, 1998

Summary

This report summarizes science analysis activities by the SAMPEX mission science team during the period during the period July 1, 1997 through July 1, 1998. Bibliographic entries for 1997 and 1998 to date (July 1998) are included. The SAMPEX science team was extremely active, with 20 articles published or submitted to refereed journals, 11 papers published in their entirety in Conference Proceedings, and 49 contributed papers, seminars, and miscellaneous presentations. The bibliography at the end of this report constitutes the primary description of the research activity. Science highlights are given under the major activity headings, as well as other activities of the team.

Scientific Investigations

a) Solar and Interplanetary Energetic Particles

Solar energetic particle (SEP) charge states were studied using the LICA, HILT, and MAST sensors, with reports generated independently for each of them. These studies concentrated on the October/November 1992 solar particle events, which were the only ones so far during the mission that generated fluxes high enough to be used for comprehensive charge state measurement by HILT and MAST.

Corotating Interaction Regions (CIRs) have been the most frequent sources of energetic particles during the 1995-97 time period, and have been studied with the high sensitivity LICA sensor, with an emphasis on composition and correlation with the Ulysses mission.

The primary results reported on these subjects during the past year were:

- A comprehensive study including LICA, HILT, and MAST measured SEP charge states in the range ~0.3-70 MeV/nucleon, and found results consistent with earlier studies, except for the Fe charge state which increased from around 11 at low energies to 14-15 at high energies. This may indicate a different source population for these different energy ranges, e.g., the corona for the higher energies, and the solar wind at low energies.

- CIR abundances measured on LICA in several events were found to be similar to the average of the solar wind composition taken between the high and low speed streams. This effect is especially important for low first ionization potential elements such as Mg and Si. This might imply some sort of mixing of particle populations from the forward- and reverse- shocks of the CIRs, but such an occurrence would be puzzling since the stream interface separating the shocks is generally considered to be impermeable to the energetic particles.

- A comprehensive study of the CIR properties during the Ulysses mission epoch was completed, using LICA, Ulysses, and IMP data. The global structure and connectivity between Earth and the Ulysses location was elucidated, and the general radial and longitude dependence of the CIR intensities revealed.

b) Magnetospheric Studies & Space Weather

Numerous studies were carried out of magnetospheric particles and space weather effects. Some of these were collaborative works using the ISTP spacecraft, as well as ground based measurements from the EISCAT radar:

- The source of energetic electrons in the outer magnetosphere was studied using SAMPEX in conjunction with input solar wind electron measurements from the WIND spacecraft. The basic question studied was: can solar wind electrons account for the population of the outer electron belt? The SAMPEX study showed that the numbers of electrons in the trapped radiation region exceeded the input from the solar wind, and therefore must have a different source.

- SAMPEX overflights of the EISCAT radar in Norway made it possible to compare the higher altitude electron fluxes with the absorption signatures detected by the radar. This information was used to study the precipitation fluxes and ion-recombination coefficients of the energetic particles as they penetrate into the atmosphere.

- In conjunction with the ISTP missions, several studies were made of geomagnetic storms and electron enhancements in the magnetosphere. An important result from this work was the demonstration that the magnetosphere responds to solar wind and other inputs (e.g., CMEs) with a larger degree of global coherence than previously believed.

- Dynamical variation of the polar cap size was determined as a function of magnetospheric activity Kp index over an extended time period.

- SAMPEX global maps of the magnetosphere were used to continue our studies of the global energization and transport of energetic particles.

- Electron precipitation in the dayside low-latitude boundary layer was studied, in order to probe the magnetic topology of the layer. It was found that the equatorward edge of the energetic electron precipitation coincides precisely with the equatorward edge of the LLBL (Lower Latitude Boundary Layer) as these boundaries move over a wide range of invariant latitude.

c) Trapped particles

- A multi-year survey of trapped low altitude equatorial heavy ions was carried out by the LICA sensor. It was found that the trapped radiation at ~0.5 MeV/nucleon had a composition essentially solar-like.

d) Anomalous Cosmic Rays

Analysis of the anomalous component of cosmic rays (ACRs) continued; the primary result presented during 1997/98 was:

- measurement of the ACR carbon abundance using the HILT sensor; this extended the earlier MAST measurements to lower energies. An important feature of the analysis was the use of the charge state of the C (+1) to separate the ACR from other, particularly solar, sources. The HILT measurements for 8-20 MeV/nucleon found ACR C/O = 2.7 ± 1.2%, considerably below some prior studies which were apparently contaminated by solar particle or interplanetary C.

Data Analysis Activities

Data analysis at UMSOC was routine, with Level-1 MDFs sent out to the investigator team approximately 2-3 weeks after receipt.

The transition to the PACOR II facility at Goddard was completed during the year. A SUN workstation was installed at UMSOC to receive PACOR II daily transmissions by internet transfer. Switching over to this facility required a modification of the PACOR II data to put it in a form that can be processed by the UMSOC level 1 software, the MDF generator program. After a period of dual-operation, the PACOR I transmissions were terminated. The X.25 line was decommissioned, and the associated modem returned to Goddard. The SAMPX1 workstation, part of the UMSOC cluster, was decommissioned after this change, since its sole duty had been the X.25 capture, and it was no longer required.

NSSDC Submission

Large team efforts continued in support of calibrated flux files for 30s averages, and polar cap average data for NSSDC. The data submission to NSSDC is in the form of "flatfiles", which contain 24 hours of 30s data, or else 1 month of polar cap average data. Submission to NSSDC is being carried out by FTP to a computer at NSSDC.

NSSDC personnel have generated the requisite tables to convert the flatfiles into CDF.

The current (7/6/98) data availability on the NSSDC WWW SPyCAT page is:

SAMPEX data on the NSSDC WWW pages:

Data Type	Period Covered:
30 second rates	July 6, 1992 - June 1, 1998
30 second fluxes	July 6, 1992 - June 1, 1998
Polar cap averaged rates	July 1992 - May 1998
Polar cap averaged fluxes	July 1992 - May 1998

Solar Geophysical Data Bulletin Submissions

SAMPEX Interplanetary Particle Fluxes for the period Jan-Jun 1995 appeared in the April 1996 (#620) issue of Solar-Geophysical Data (SGD) Comprehensive Reports. A summary of the submissions to date is below.

Dates of data	SGD vol.	SGD issue date
Jul-Dec 1992	#595	March 1994
Jan-Jun 1993	#596	April 1994 - revised in issue #606
Jan-Dec 1993	#606	February 1995
Jan-Dec 1994	#618	February 1996
Jan-Jun 1995	#620	April 1996
Jul-Dec 1995	#632	April 1997
Jan-Feb 1997	#633	May 1997

World Wide Web site

The SAMPEX WWW site (http://lepsam.gsfc.nasa.gov/www/sampex.html) has had over 11,400 accesses by non-team members (through 4/28/98). About 3700 of these were from Europe, Asia, and Canada. The page layout was recently updated, and contains sub-sections:

SAMPEX SPACECRAFT

- Description of the spacecraft, its subsystems and orbit.

SAMPEX INSTRUMENTS

- Instrument descriptions, their science objectives and full publications.

SAMPEX SCIENCE TOPICS

- Examples of scientific investigations together with data and images and list of SAMPEX discoveries.

SAMPEX INSTITUTIONS AND PEOPLE

- People and institutions comprising the SAMPEX collaboration.

SAMPEX PUBLIC INFO & DATA

- Science data in the form of plots and images, including all monthly plots that appear in the *Solar Geophysical Data* books

THE COOPERATIVE SATELLITE LEARNING PROJECT

- A joint project between government, industry, and the public education system to capture and channel students towards science and engineering curriculum and careers in the space industry.

SAMPEX INTERNAL MEMOS

Team Meetings

Team meetings are held to exchange results, coordinate current and future analysis projects, and plan future spacecraft/instrument operations. Two meetings were held during the reporting period, one hosted by the SAMPEX co-investigator group at the Max-Planck-Institute, Munich, and the other hosted by the SAMPEX co-investigator group at NASA Langley Research Center:

SAMPEX Science Team Meeting #15
September 29 - October 1, 1997

Hotel Fürstenhaus
A-6213 Pertisau, Austria

SAMPEX Science Team Meeting #16
May 4-5, 1998

NASA Langley Research Center
Hampton VA, 23655

Spacecraft & Instrument Health and Operations

The SAMPEX spacecraft and instruments remained in excellent operating condition. Highlights during the period were:

The SAMPEX spinning in 1 RPM spin mode commenced on May 8, 1996 and continued until November 6, 1997, when the spacecraft was spun-down in order to measure solar energetic particle ionization states in an intense solar particle event. After the particle event was over, the spacecraft was spun up again to 1 RPM. From mid-December to mid-January, the spacecraft went back to 1 rev per orbit mode to do an ACR intercalibration with the ACE spacecraft. Thereafter, 1 RPM spinning commenced again until April 21, 1998, when another powerful solar event took place. The spacecraft was spun up to 1 RPM after this, but on May 7, 1998, was returned to 1 rev per orbit mode in preparation for future solar particle events. The team will continue reexamine the operations in this mode from time to time in order to determine the observing strategy expected to yield maximum science returns.

Bibliography

Journal Articles:

1. Baker, D. N., Clementine particle measurements in lunar orbit, *Adv. Space Res., 19,* 1587-1591, 1997.

2. Baker, D. N., What is space weather, *Adv. Space Res., in press,* 1997.

3. Baker, D. N., X. Li, J. B. Blake, L. B. Callis, D. Hovestadt, B. Klecker, and S. Kanekal, Strong electron acceleration in the Earth's magnetosphere, *Adv. Space Res.,* 1997.

4. Baker, D. N., H. E. Spence, and J. B. Blake, ISTP and cosmic plasma processes: relativistic particle acceleration and global energy transport, *Adv. Space Res., in press,* 1997.

5. Oetliker, M., B. Klecker, D. Hovestadt, M. C. McNab, J. B. Blake, and G. M. Mason, The abundance of carbon in the anomalous cosmic rays, *Astrophys. J. (Letters), submitted July 1997,* 1997.

6. Oetliker, M., B. Klecker, D. Hovestadt, G. M. Mason, J. E. Mazur, R. A. Leske, R. A. Mewaldt, J. B. Blake, and M. D. Looper, The ionic charge of solar energetic particles with energies of 0.3-70 MeV/nucleon, *Astrophys. J., 477,* 495-501, 1997.

7. Mason, G. M., J. E. Mazur, J. R. Dwyer, D. V. Reames, and T. T. von Rosenvinge, New spectral and abundance features of interplanetary heavy ions in corotating interaction regions, *Astrophys. J. (Letters), 486,* L149-L152, 1997.

8. Li, X., D. N. Baker, M. Temerin, T. Cayton, G. C. Reeves, T. Araki, H. Singer, D. Larson, R. P. Lin, and S. G. Kanekal, Energetic electron

injections into the inner magnetosphere during the January 10-11, 1997 magnetic cloud event, *Geophys. Res. Letters, submitted*, October 1997, 1997.

9. Li, X., D. N. Baker, M. Temerin, D. Larson, R. P. Lin, E. G. D. Reeves, M. Looper, S. G. Kanekal, and R. A. Mewaldt, Are energetic electrons in the solar wind the source of the outer radiation belt?, *Geophys. Res. Letters, 24*, 923-926, 1997.

10. Baker, D. B., *et al.*, Recurrent geomagnetic storms and relativistic electron enhancements in the outer magnetosphere: ISTP coordinated measurements, *J. Geophys. Res., 102*, 14141-14148, 1997.

11. Baker, D. N., T. Pulkkinen, X. Li, S. G. Kanekal, J. B. Blake, R. S. Selesnick, M. G. Henderson, G. D. Reeves, H. E. Spence, and G. Rostoker, Coronal mass ejections, magnetic clouds, and relativistic magnetospheric electrons: ISTP, *J. Geophys. Res., submitted*, 1997.

12. Callis, L. B., M. Natarajan, D. Evans, and J. D. Lambeth, Solar-Atmospheric Coupling by Electrons (SOLACE), Part I: Effects of the May 12, 1997 Solar Event on the Middle Atmosphere", *J. Geophys. Res., submitted*, xxx, 1997.

13. Callis, L. B., M. Natarajan, and J. D. Lambeth, On the origin of midlatitude ozone changes: data analysis and simulations for 1979-1993, *J. Geophys. Res., 102*, 1215, 1997.

14. del Pozo, C. F., I. W. McCrea, J. B. Blake, M. D. Looper, and J. K. Hargreaves, Electron precipitation fluxes and effective ion-recombination coefficients from simultaneous EISCAT/SAMPEX observations, *J. Geophys. Res., submitted*, 1997.

15. Li, X., D. N. Baker, M. Temerin, T. E. Cayton, E. G. D. Reeves, R. A. Christensen, J. B. Blake, R. Nakamura, and S. G. Kanekal, Multi-satellite observations of the outer zone electron variation during the 3-4 November 1993 magnetic storm, *J. Geophys. Res., 102, (A7)*, 14123-14140, 1997.

16. McCrea, I. W., J. B. Blake, C. F. del Pozo, D. M. Willis, M. D. Looper, P. C. Anderson, and B. Klecker, Coordinated EISCAT, SAMPEX Studies of Energetic Particle Precipitation above EISCAT, *J. Geophys. Res., in press,* 1997.

17. Mazur, J. E., G. M. Mason, and M. E. Greenspan, The elemental composition of low altitude 0.5 MeV/nucleon trapped equatorial ions, *Geophys. Res. Letters, 25, (6),* 849-852, 1998.

18. Blanchard, G. T., L. R. Lyons, J. B. Blake, and F. J. Rich, SAMPEX Observations of Energetic Electron Precipitation in the Dayside Low-Latitude Boundary Layer, *J. Geophys. Res., 103,* 191-198, 1998.

19. Kanekal, S. G., D. N. Baker, J. B. Blake, B. Klecker, J. R. Cummings, R. A. Mewaldt, G. M. Mason, and J. E. Mazur, High-latitude energetic particle boundaries and the polar cap: a statistical study, *J. Geophys. Res., 103,* 9367-9372, 1998.

20. Richardson, I. G., J. E. Mazur, and G. M. Mason, A comparison of recurrent energetic ion enhancements observed at Ulysses and at 1 AU by IMP-8 and SAMPEX: *Ulysses* launch until following the first north polar passage, *J. Geophys. Res., 103,* 2115-2129, 1998.

Conference Proceedings:

1. Schmierman, J. and D. K. Schmidt, Simultaneous Gyroless Attitude and Orbit Determination with Magnetometer, *Amer. Inst. Aero. & Astro./Am. Astro. Soc. (AIAA/AAS) Astrodynamics Conference, July 1997*, 1997.

2. Blake, J. B., M. C. McNab, and M. Schulz, Numerical studies of the geomagnetic trapping of anomalous cosmic rays, *Proc. 25th Internat. Cosmic Ray Conf. (Durban, South Africa)*, 2, 301-304, 1997.

3. Cummings, A. C., E. C. Stone, B. Klecker, R. G. Marsden, R. A. Mewaldt, D. V. Reames, K. J. Trattner, T. T. von Rosenvinge, and W. R. Webber, Intensity gradients of anomalous cosmic ray oxygen throughout the heliosphere, *Proc. 25th Internat. Cosmic Ray Conf. (Durban, South Africa)*, 2, 257-260, 1997.

4. Klecker, B., M. Oetliker, J. B. Blake, D. Hovestadt, G. M. Mason, J. E. Mazur, and M. C. McNab, Multiply charged anomalous cosmic ray N, O, and Ne: observations with HILT / SAMPEX, *Proc. 25th Internat. Cosmic Ray Conf. (Durban, South Africa)*, 1, 273-276, 1997.

5. Leske, R. A., R. A. Mewaldt, A. C. Cummings, E. C. Stone, and T. T. von Rosenvinge, Updated measurements of the isotopic composition of interplanetary and geomagnetically trapped anomalous cosmic rays, *Proc. 25th Internat. Cosmic Ray Conf. (Durban, South Africa)*, 2, 321-324, 1997.

6. Leske, R. A., R. A. Mewaldt, E. C. Stone, and T. T. von Rosenvinge, Geomagnetic cutoff variations during solar energetic particle events -- implications for the space station, *Proc. 25th Internat. Cosmic Ray Conf. (Durban, South Africa)*, 2, 381-384, 1997.

7. Oetliker, M., B. Klecker, D. Hovestadt, G. M. Mason, J. E. Mazur, J. B. Blake, M. D. Looper, R. A. Leske, and R. A. Mewaldt, The ionic charge of

solar energetic particles with energies of 0.3 - 70 MeV per nucleon, *Proc. 25th Internat. Cosmic Ray Conf. (Durban, South Africa), 1*, 93-96, 1997.

8. Oetliker, M., B. Klecker, G. M. Mason, M. C. McNab, and J. B. Blake, The abundance of anomalous cosmic ray carbon in the inner heliosphere, *Proc. 25th Internat. Cosmic Ray Conf. (Durban, South Africa), 1*, 277-280, 1997.

9. Selesnick, R. S., R. A. Leske, R. A. Mewaldt, and J. R. Cummings, Geomagnetically trapped anomalous cosmic rays at solar minimum, *Proc. 25th Internat. Cosmic Ray Conf. (Durban, South Africa), 1*, 305-308, 1997.

10. Selesnick, R. S., R. A. Mewaldt, and J. R. Cummings, Multiply charged anomalous cosmic rays above 15 MeV/nucleon, *Proc. 25th Internat. Cosmic Ray Conf. (Durban, South Africa), 1*, 266-272, 1997.

11. Mason, G. M., *et al.*, SAMPEX: NASA's first Small Explorer satellite, *IEEE Aerospace Conference, Abstract vol., paper B.101*, 135, 1998.

Contributed papers & miscellaneous:

1. Mason, G. M., Systematics of CIR heavy ion composition as a function of heliospheric latitude and radius: report of the composition working subgroup, *University of Kiel, 2nd CIR workshop at Schloss Elmau,* Elmau, Germany, May 2, 1997.

2. Mason, G. M., J. E. Mazur, J. R. Dwyer, D. V. Reames, and T. T. von Rosenvinge, New spectral and abundance features of interplanetary heavy ions in corotating interaction regions, *University of Kiel, 2nd CIR workshop at Schloss Elmau,* Elmau, Germany, April 28 - May 2, 1997.

3. Richardson, I. G., J. E. Mazur, and G. M. Mason, A comparison of recurrent energetic ion enhancements at the *Ulysses* spacecraft and IMP-8/SAMPEX from launch until the first north polar passage, *University of Kiel, 2nd CIR workshop at Schloss Elmau,* Elmau, Germany, April 28 - May 2, 1997.

4. McConnell, C. and D. K. Schmidt, Attitude and Trajectory Estimation Using Magnetometer Only, *NASA / Goddard Space Flight Center, 1997 Flight Mechanics Conference,* Greenbelt, MD, May 1977.

5. McConnell, C. and D. K. Schmidt, A Comparative Study of the Flight Dynamics and Control Laboratory's Orbital Analysis System with the Goddard Trajectory Determination System(GTDS), *NASA / Goddard Space Flight Center, 1997 Flight Mechanics Conference,* Greenbelt, MD, May 1997.

6. Mason, G. M., Recent Science Results from SAMPEX, *Department of Physics, University of Maryland, Goddard/University of Maryland Space Physics Seminar,* College Park, MD, Nov. 3, 1997.

7. Mewaldt, R. A., The acceleration of interstellar material at the solar wind termination shock, *Jour. American Astron. Society, xx,* xx, 1997.

8. Mason, G. M., Latest results from SAMPEX, *American Center for Physics, Maryland-Goddard Interaction Day,* College Park, MD, February 14, 1997.

9. Mewaldt, R. A., The anomalous cosmic rays: a wayward sample of interstellar matter", *NASA, NASA JOVE Retreat,* Pasadena, CA, July 2, 1997.

10. Mewaldt, R. A., Anomalous cosmic rays from SAMPEX, *California Institute of Technology, Physics 10b research opportunities,* Pasadena, CA, February 17, 1997.

11. Blake, J. B., G. M. Mason, J. E. Mazur, B. Klecker, and T. T. von Rosenvinge, Polar cap access during the small solar particle event of 30 November 1996, *Proc. 25th Internat. Cosmic Ray Conf. (Durban, South Africa),* 1997.

12. Klecker, B., M. Oetliker, J. E. Mazur, J. B. Blake, D. Hovestadt, and G. M. Mason, Measurement of anomalous cosmic ray composition and energy spectra at 1 AU for solar minimum conditions (1992 - 1995), *Proc. 25th Internat. Cosmic Ray Conf. (Durban, South Africa),* 1997.

13. Oetliker, M., G. M. Mason, B. Klecker, J. B. Blake, and M. C. McNab, ACR elemental abundances of C, N, O, and Ne measured with HILT on SAMPEX, *Proc. European Geophys. Soc.,* 1997.

14. Baker, D. N., The Third IAGG Campaign, *Trans. Am. Geophys. U., 78,* F575, 1997.

15. Baker, D. N., X. Li, T. Pulkkinen, S. G. Kanekal, R. Selesnick, M. G. Henderson, G. D. Reeves, and H. E. Spence, Coronal mass ejections, magnetic clouds, and relativistic magnetospheric electron events, *Trans. Am. Geophys. U., 78,* S283, 1997.

16. Baker, D. N. and T. I. Pulkkinen, Magnetic reconnection during magnetospheric substorms, *Trans. Am. Geophys. U., 78,* S303, 1997.

17. Callis, L. B., M. Natarajan, D. S. Evans, and J. D. Lambeth, Solar-atmospheric coupling by electrons (SOLACE): middle atmospheric effects of the May 12, 1997 event, *Trans. Am. Geophys. U., 78*, F508, 1997.

18. Cummings, A. C. and E. C. Stone, Location of the solar wind termination shock, *Trans. Am. Geophys. U., 78*, F546, 1997.

19. Cummings, J. R., R. S. Selesnick, R. A. Leske, and R. A. Mewaldt, Geomagnetically trapped anomalous cosmic rays at solar cycle minimum, *Trans. Am. Geophys. U., 78*, S263, 1997.

20. Greenspan, M. E., J. E. Mazur, and G. M. Mason, Solar cycle dependence of storm-time low altitude equatorial particle fluxes measured by SAMPEX LICA, *Trans. Am. Geophys. U., 78*, F598, 1997.

21. Kanekal, S. G., D. N. Baker, J. B. Blake, B. Klecker, G. M. Mason, and R. A. Mewaldt, Magnetospheric response to the Jan '97 magnetic cloud observed by SAMPEX and POLAR, *Trans. Am. Geophys. U., 78*, S288, 1997.

22. Kanekal, S. G., D. N. Baker, J. B. Blake, B. Klecker, G. M. Mason, and R. A. Mewaldt, SAMPEX and POLAR energetic particle observations of the magnetospheric response to the early 1997 magnetic cloud and CME events, *Trans. Am. Geophys. U., 78*, F608, 1997.

23. Klecker, B., R. A. Mewaldt, and A. C. Cummings, Anomalous cosmic rays: a report from the ISSI workshop on cosmic rays in the heliosphere, *Trans. Am. Geophys. U., 78*, F546, 1997.

24. Klecker, B., M. Oetliker, R. A. Mewaldt, and R. A. Leske, A search for minor ions in anomalous cosmic rays, *Trans. Am. Geophys. U., 78*, F531, 1997.

25. Leske, R. A., R. A. Mewaldt, A. C. Cummings, E. C. Stone, and T. T. von Rosenvinge, Updated isotopic composition measurements of

geomagnetically filtered and geomagnetically trapped anomalous cosmic rays, *Trans. Am. Geophys. U., 78*, S263, 1997.

26. Li, X., D. B. Baker, M. Temerin, D. Larson, R. P. Lin, T. Cayton, E. G. D. Reeves, T. Araki, H. Singer, and S. G. Kanekal, Energetic electron injections into the inner magnetosphere during the January 10-11, 1997 magnetic cloud event, *Trans. Am. Geophys. U., 78*, F575, 1997.

27. Li, X., D. N. Baker, M. Temerin, D. Larson, R. P. Lin, E. G. D. Reeves, J. B. Blake, M. Looper, R. Selesnick, and R. A. Mewaldt, Simultaneous observations by multi-spacecraft of solar wind and outer radiation belt electrons, *Trans. Am. Geophys. U., 78*, S277, 1997.

28. Marsden, R. G., A. C. Cummings, R. A. Mewaldt, and B. Klecker, Anomalous cosmic ray data sets, *Trans. Am. Geophys. U., 78*, F531, 1997.

29. Mason, G. M., J. R. Dwyer, J. E. Mazur, D. V. Reames, and T. T. von Rosenvinge, New spectral and abundance features observed in low energy CIR heavy ions, *Trans. Am. Geophys. U., 78*, F547, 1997.

30. Mazur, J. E., G. M. Mason, and M. E. Greenspan, The elemental composition of low altitude 0.5 MeV/nucleon trapped equatorial ions, *Trans. Am. Geophys. U., 78*, F590, 1997.

31. Mewaldt, R. A., R. S. Selesnick, and J. R. Cummings, Multiply ionized anomalous cosmic rays from above 15 MeV/nucleon, *Trans. Am. Geophys. U., 78*, S263, 1997.

32. Mewaldt, R. A., R. S. Selesnick, B. Klecker, and M. Oetliker, SAMPEX measurements of the ionic charge composition of anomalous cosmic rays, *Trans. Am. Geophys. U., 78*, F546, 1997.

33. Moorer, D. F. and D. N. Baker, Outer electron radiation belt modeling by assimilation of satellite flux data, *Trans. Am. Geophys. U., 78*, F597, 1997.

34. Moorer, D. F., D. N. Baker, and S. Fung, Outer electron belt modeling by assimilation of real-time satellite flux data, *Trans. Am. Geophys. U., 78,* S306, 1997.

35. Nakamura, R., K. Kamei, Y. Kamide, M. Isowa, D. B. Baker, J. B. Blake, and M. D. Looper, Storm-associated electron flux changes observed by SAMPEX, *Trans. Am. Geophys. U., 78,* F589, 1997.

36. Richardson, I. G., H. V. Cane, G. M. Mason, and J. E. Mazur, Corotating particle and solar wind structures during the 1990's solar minimum and the previous two solar minima: evidence for a 22 year cycle, *Trans. Am. Geophys. U., 78,* F550, 1997.

37. Thayer, M. R., A. C. Cummings, R. A. Leske, R. A. Mewaldt, E. C. Stone, and M. D. Looper, A search for anomalous hydrogen at 1 AU with SAMPEX, *Trans. Am. Geophys. U., 78,* F531, 1997.

38. Wilken, B., D. N. Baker, T. Doke, T. Mukai, N. Hasebe, G. D. Reeves, and S. Ullaland, Observations of energetic oxygen bursts and recurrent magnetospheric activity between Dec. 1993 and June 1994, *Trans. Am. Geophys. U., 78,* S284, 1997.

39. Williams, D. L., R. A. Leske, R. A. Mewaldt, E. C. Stone, R. S. Selesnick, J. R. Cummings, and T. T. von Rosenvinge, MAST measurements of solar energetic particle isotopic composition, *Trans. Am. Geophys. U., 78,* S260, 1997.

40. Mewaldt, R. A., The anomalous cosmic rays -- interstellar material in our own back yard, *Butler University,* Indianapolis, Indiana, 2/11/98.

41. Blake, J. B., Issues and data pertinent to assessing relativistic electron hazard to the Space Station, *National Research Council Space Studies Board, Committee on Solar and Space Physics,* Woods Hole, MA, June 29, 1998.

42. Mewaldt, R. A., New measurements on anomalous cosmic rays, *NASA / GSFC, GSFC LHEA seminar series,* Greenbelt, MD, 2/10/98.

43. Kanekal, S. G., D. N. Baker, J. B. Blake, L. B. Callis, B. Klecker, R. A. Mewaldt, G. M. Mason, and the SAMPEX team, The SAMPEX World Wide Web Data and Information System, *Trans Am. Geophys. U., 79*, S251, 1998.

44. Baker, D. N., Solar disturbances and geospace consequences: more results from campaign 3, *Trans. Am. Geophys. U., 79*, S329, 1998.

45. Kanekal, S. G. and D. N. Baker, Jovian electrons in the Earth's polar regions, *Trans. Am. Geophys. U., 79*, S319, 1998.

46. Looper, M. D., J. B. Blake, and R. A. Mewaldt, SAMPEX observations of energetic particle albedo over the polar caps, *Trans. Am. Geophys. U., 79*, S263, 1998.

47. Mason, G. M., *et al.*, Solar Energetic Particle Composition and Spectra During the November 1997 Solar Particle Events, *Trans. Am. Geophys. U., 79*, S255, 1998.

48. Mazur, J. E., G. M. Mason, M. D. Looper, and R. A. Mewaldt, Charge states of solar energetic particles using the geomagnetic cutoff technique: SAMPEX measurements in the 1997 November solar particle events, *Trans. Am. Geophys. U., 79*, S256, 1998.

49. Reeves, G. D., T. E. Cayton, R. H. W. Friedel, J.-M. Jain, M. G. Henderson, M. M. Meier, D. N. Baker, S. G. Kanekal, J. B. Blaker, J. R. Fennell, and R. S. Selesnick, Relativistic electron observations on the three-dimensional magnetosphere, *Trans. Am. Geophys. U., 79*, S321, 1998.